
A current perspective on medical informatics and health sciences librarianship

By Gerald J. Perry, MLS, AHIP*
jerry.perry@uchsc.edu
Deputy Director

Denison Memorial Library
University of Colorado Health Sciences Center
4200 East Ninth Avenue, A003
Denver, Colorado 80262

Nancy K. Roderer, MLS, AHIP*
nroderer@jhmi.edu
Assistant Professor and Interim Director

Division of Health Sciences Informatics
School of Medicine, and
Director
Welch Library

Johns Hopkins University
1900 East Monument Street
Baltimore, Maryland 21205

Soraya Assar, MLS†
soraya.assar@eclipsys.com
Health Sciences Informatics Fellow

Division of Health Sciences Informatics
Johns Hopkins University
2024 East Monument Street, Suite 1-202
Baltimore, Maryland 21205

Objective: The article offers a current perspective on medical informatics and health sciences librarianship.

Narrative: The authors: (1) discuss how definitions of medical informatics have changed in relation to health sciences librarianship and the broader domain of information science; (2) compare the missions of health sciences librarianship and health sciences informatics, reviewing the characteristics of both disciplines; (3) propose a new definition of health sciences informatics; (4) consider the research agendas of both disciplines and the possibility that they have merged; and (5) conclude with some comments about actions and roles for health sciences librarians to flourish in the biomedical information environment of today and tomorrow.

Summary: Boundaries are disappearing between the sources and types of and uses for health information managed by informaticians and librarians. Definitions of the professional domains of each have been impacted by these changes in information. Evolving definitions reflect the increasingly overlapping research agendas of both disciplines. Professionals in these disciplines are increasingly functioning collaboratively as “boundary spanners,” incorporating human factors that unite technology with health care delivery.

INTRODUCTION

In 1994, the ever-prescient Matheson delivered the American College of Medical Informatics Distinguished Lecture at the 18th Annual Symposium on Computer Applications in Medical Care. Exhorting her peers to consider the central challenge for the fields of medical informatics and librarianship, she advocated forming a new organization to lead the development of postmodern digital knowledge management systems for biomedicine [1]. Much of what Matheson predicted in her lecture has either come true or soon will, in particular the advent of university- and discipline-specific digital repositories representing the intellectual capital of academe and the fundamentally transforming paradigm shift now being experienced as the roles of libraries and scholars evolve as a result of the widespread digitization of scholarly communications. The organization that she called for, however, has not materialized.

A year after Matheson advocated merging fields and interests, Frisse et al., writing from a library perspective, argued that

The birth of new forms of institutional and corporate knowledge created from aggregate data raises the potential for a new form of librarianship that will require a synergistic reformulation of the roles of both the medical informatician and the librarian. [2]

Both Matheson and Frisse et al. focused on roles and interests, and both advocated combining professional agendas to develop and deliver digital knowledge management systems to advance the health sciences.

In the eight years since the Frisse et al. article and the nine years since Matheson's lecture, how have definitions of medical informatics evolved and changed in relation to health sciences librarianship and the broader domain of information science? Where do the scopes and research agendas of health sciences librarianship and medical informatics overlap, and where do they diverge? Also, what progress has been made in articulating and realizing new roles for biomedical librarians in relation to the developing professional discipline of medical informatics?

DEFINITIONS

Frissé et al. defined medical informatics as being at the crossroads between biomedical science and information technology, with a focus on developing and delivering information systems that support health care, decision making, databases for outcomes analysis, and health sciences research and administration. Health

sciences librarianship was viewed as theorizing about and applying organizational and management technologies to biomedical scholarly communications. The authors noted that their definition of informatics focused on tasks for the field and did not encompass informatics' intellectual scope, so that their description of librarianship was in fact relevant to both librarianship and informatics as the disciplines then existed.

Given the continued evolution of both informatics and librarianship, it is worthwhile to review some additional definitional aspects and to further consider the relationships between informatics, health sciences librarianship, and the broader domain of information science. Varied terminology is used in the informatics field. One approach differentiates areas of informatics by the practice area covered, as in clinical informatics, nursing informatics, public health informatics, and so on. Some practitioners use the term bioinformatics to reflect informatics activity related to the basic sciences, most especially those dealing with genetics. Others use the term bioinformatics to describe the range of subdisciplines in the broad area of informatics applications in the health sciences. The American Medical Informatics Association encompasses the subdisciplines under the general term "medical informatics," although changing the association's name has been regularly discussed.

Four definitions of informatics, created over a span of more than twenty-five years, illustrate key elements in the evolution of the field:

■ 1977: Medical informatics is the application of computer technology to all fields of medicine—medical care, medical teaching, and medical research. [3]

■ 1984: Medical informatics comprises the theoretical and practical aspects of information processing and communication, based on knowledge and experience derived from processes in medical and health care. [4]

■ 1990: We define medical informatics as the rapidly developing scientific field that deals with the storage, retrieval, and optimal use of biomedical information, data, and knowledge for problem solving and decision making. [5]

■ 2003: Biomedical informatics is the interdisciplinary science that deals with biomedical information, its structure, acquisition, and use. "Biomedical" is used here in its broadest sense, to include research, education, and service in health-related basic sciences, clinical disciplines, and health care administration. Biomedical informatics is grounded in the principles of computer science, information science, cognitive science, social science, and engineering, as well as the clinical and basic sciences. Biomedical informatics encompasses a spectrum similar in scope to the sequence from mathematics to physics to engineering. It includes scientific endeavors ranging from theoretical model construction to the building and evaluation of applied systems. [6]

Another recent definition of informatics, put forth by Stead as a simplification but nonetheless capturing the essence of the field, is, "medical informatics is the

* Support for Nancy K. Roderer's and Gerald J. Perry's involvement in this article was provided in the context of the US National Library of Medicine/Association of Academic Health Sciences Libraries Leadership Fellows Program (Association of Research Libraries Website <<http://www.arl.org/olms/fellows/>>).

† Support for Soraya Assar is provided by grant 1 T15 LM07452-01 from the National Library of Medicine.

science that deals with health information, its structure, acquisition and use" [7].

Since Frisse et al. wrote their article, the discipline of health sciences informatics has significantly broadened, with the beginnings of greater integration of concepts in the field's component parts. In 1995, recognized areas of informatics concerned clinical medicine, nursing, and dentistry. Over time, every discipline under the umbrella of health sciences has recognized the extension of concepts related to advanced computing technologies to the delivery of patient care.

In recent years, informatics concepts have additionally been useful in dealing with other health-related kinds of data, especially basic science and public health information. While built on similar principles of information management, each discipline has unique needs with diverse types of data and unique and often disparate operations performed on that information. New subfields of informatics continue to be identified, and a number of professional medical societies now recognize informatics activities related to the particular data, information, and knowledge in their domain. Examples include primary care and oncology informatics [8]. How then do evolving definitions of informatics and the expanding nature of its professional domain affect and relate to the already established domains of library and information science?

LIBRARY AND INFORMATION SCIENCE

The online service, hyperdictionary <<http://www.hyperdictionary.com>>, defines information science as an aggregation of sciences "concerned with gathering and manipulating and storing and retrieving and classifying recorded information." The service in turn defines library science as "the study of the principles and practices of library administration."

Librarianship is generally taught in schools of library and information science, which in general present library science as a specific instance of the broader field of information science. The meaning of the term information science is somewhat explicated by a self-referential statement of the American Society for Information Science and Technology (ASIS&T): "information professionals leading the search for new and better theories, techniques, and technologies to improve access to information" [9].

In a discussion of the terms "librarianship" and "information science," Buckland declines to define librarianship or library science but, instead, points out that rhetoric about the two is dominated by references to a well-understood institution, the library. He also notes that librarianship is a subset of information science, sharing with it many of the same concerns about and approaches to information [10]. Missing from the aforementioned definition of information science, but included in that of informatics, is an explicit mention of information use. Library science has, additionally, long considered the uses to which information is put as being well within its domain. The focus of library

services and the audience for library resources are the users of information, and librarianship as a profession is highly attentive to the needs of users and the purposes for which they intend to use information.

Defining library science solely as the application of information management technologies in the context of a place—the library—is highly problematic as libraries become less a place and more a constellation of services and resources delivered in a place called the library but also virtually through digital media via digital network infrastructures. Librarians now manage digital rights, network access and authentication, and point-of-care delivery of knowledge-based information resources and mine and filter data, activities that at the time of Frisse et al.'s 1995 article would have been presumed by many librarians to lie squarely in the domain of medical informatics.

Informatics and librarianship, with their additional focus on the uses (and users) of information, can therefore be seen as expanding the domain of information science. Librarianship, operating in an increasingly digital context and with a focus on information management and information users and uses, can be seen as expanding in scope to the point where, as a discipline, its purview is very closely akin to that of informatics.

LIBRARIANSHIP AND MEDICAL INFORMATICS COMPARED

What is the current environment for health sciences librarianship and medical informatics? While the underlying shared mission of delivering relevant information has not changed, three significant factors have decreased the distance between the two disciplines. The broadening of medical informatics, the blurring of distinctions among different types of materials, and the movement of libraries to predominantly digital services has allowed librarianship and medical informatics the opportunity to develop a synergistic relationship combining the strengths of both disciplines. Commonalities of mission and commitment exist between informaticians and librarians.

First and foremost, both emphasize the delivery of relevant information to clients in laboratories, clinics and workplaces. Developers of clinical information systems demonstrate their commitment through their emphasis on effective computer-human interfaces and on point-of-care patient information systems. Librarians demonstrate a similar commitment by developing sustainable centralized resources and strategies for delivering information to clients in their clinical and laboratory settings. [2]

Differences of mission focus on the manner of support, keying in on the more concrete outputs of the disciplines, rather than the theoretical and abstract underpinnings. For informaticians, clinical information systems (CIS) have historically been a central consideration. Although librarians are becoming involved in CIS development, creation, and maintenance, the primary responsibility of librarianship continues to be in

the area of traditional information resource management.

Differences are additionally recognizable in the manner that the domains use and create information and collections. In CIS, information is entered by a host of care providers and may or may not be attributable. Access to the medical record can be restricted according to the roles of both author and reader. In contrast, for the sorts of information with which librarians have typically been concerned, authors are specific and the product of their scholarly communications is ideally directed to the widest possible audience. Barriers to access in scholarly communication are typically a result of commercial arrangements. Whereas books, journals, and other primarily peer-reviewed knowledge artifacts have been viewed as traditional information resources, increasingly the patient record in digital format, commonly referred to as the digital patient record (DPR), is also being regarded as a repository of content.

Informaticians and librarians equally apply advanced communications and data management technologies. Formerly a differentiating signifier between the domains of informatics and librarianship, fluency in the use of technology has emerged as an indispensable and essential requirement for operating efficiently in both domains. Given the sophisticated manner with which libraries manage and deliver access to digital knowledge products and the advent of advanced services such as support for evidence-based health care practice as well as the complex nature of delivering technology in the health care setting, librarians and informaticians understand that the success of their institutions rests on both disciplines' ability to exploit technology to its fullest potential.

Information management principles grounded in library science have been recognized as useful in the medical setting. The Association of American Medical College's Better Health 2010 report states:

Essential knowledge and skills for managing the health information environment reside in many areas including the library, informatics, computer support, administrative services and clinical and research disciplines. The stewardship approach that libraries have traditionally used—selection, storage, organization, preservation, creating means for intellectual and physical access, etc.—applies well to the management of knowledge resources in any form. The concept of the library can be a useful framework for designing the information environment of 2010. [11]

A NEW DEFINITION OF HEALTH SCIENCES INFORMATICS

Given the continuing evolution of the fields of information science, librarianship, and health sciences informatics, the authors propose that definitions of the latter two can best be captured at this time as follows:

Health sciences informatics is the science that deals with health-related information, its structure, acquisition, and use. Health sciences librarianship and informatics are heavily

overlapping disciplines with strong conceptual links to the theoretical discipline of information science.

RESEARCH AGENDAS IN LIBRARIANSHIP AND INFORMATICS

Dalrymple argues that librarianship and biomedical informatics compete over similar research agendas. Both librarians and informaticians explore key research areas: determining optimal therapeutic interventions, effectively delivering information at point of need, and ascertaining productive health care delivery economic models. Both disciplines are engaged in creating knowledge products and resources, in collaborating on the development of information systems, and in conducting research in information usage. Additionally, informaticians and librarians are both considering how best to integrate filtered knowledge into decision support systems, with both domains actively researching how information is used by clinicians and researchers [12].

Bradley similarly suggests overlapping agendas. Pointing to Abbott's system theory of professions, she observes that new concepts of information bring new possibilities for expert work and that such possibilities are being explored by both librarians and informaticians. She describes the "heartland" work serving as the basis for exploration by librarians and informaticians, with informaticians addressing information issues from a computer systems perspective and librarians addressing similar issues from a management point of view [13, 14].

Librarians will continue to have a role in transforming the health information environment, if, as a profession, they apply and advance their historic and evolving strengths in key areas of expert work. Skills in the areas of information organization, collection management, information analysis, information services, and user training are all relevant, as is the librarian's deep knowledge of scholarly communication patterns. Organizational issues include all aspects of controlled vocabulary; organizing information according to anticipated user needs; and abstracting, indexing, and descriptive cataloging. Librarians have expertise and skill in maintaining and preserving knowledge artifacts, in both paper and electronic forms. They have experience with helping users match their information needs to knowledge-based information, with quality filtering of knowledge artifacts, with supporting in-context and just-in-time services, and with training on information systems at the point of use [13].

Stead et al.'s "generational" view provides a context for examining research agendas in health sciences informatics. These authors have proposed a history of medical informatics projects along a continuum of three generations or dimensions. Early projects involved creating databases and using them for multiple purposes, the next generation integrated various databases or sources using enterprise information architecture, and the third phase concerned interrelating

heterogeneous information sources to provide the appearance of integration. At the third stage, which involves integrating the greatest number and variety of information sources, the need is greater for information players to collaborate, particularly in dealing with use and quality assessments of both information and systems [15].

Lynch also notes increasing needs to integrate medical information for use and suggests that this integration can be achieved in part by information extraction through data mining and data filtering [16]. Finally, given the scattered nature of the primary literature as well as the limitations of the metadata structures applied to the literature, retrieval of all potentially relevant information is nearly impossible [17]. Rich research opportunities exist to improve the production and indexing of the literature used to support decision making.

In health sciences informatics, a consistent focus of research continues to be the DPR, as well as the relationship of the DPR to aggregated information about defined communities or populations. Lynch sees the DPR as a rich source of data and foresees an enormous information management challenge in addressing the growth of the record, particularly as it comes to be used to capture data in a continuous fashion through the application of integrated sensors (readings of blood sugar, blood pressure, etc., for example). Lynch further sees potential in the integration of the DPR and knowledge-based information: "We can view a patient record as a standing current awareness query on the part of the attending physicians, patient, and interested researchers against the various 'literatures'" [16].

Humphreys envisions the DPR linked to a broader digital library of knowledge artifacts:

Given an expansive definition of the digital library, collections of data aggregated from individual health records, like the clinical data warehouse or the population health data set, can be viewed as part of the larger digital library needed to support biomedical research, education, and informed health care decisions. This is a useful view for institutions that develop and provide access to digital health data and to knowledge-based information. Regarding aggregated health data as part of the digital library not only opens up new funding opportunities but may also encourage fruitful multidisciplinary cooperation on problems common to knowledge-based information and aggregated health data, including permanent retention of electronic information or the need to implement variable user access privileges. [18]

Blois and Shortliffe suggest that there are four key issues constraining efforts to advance the DPR—the need for lexical standards, data privacy, confidentiality, and security—concerns shared by Humphreys, Lynch, and many others. They additionally see challenges for data entry by physicians and the integration of patient record systems with other data sources, including filtered evidence. Blois and Shortliffe's vision for the future of the DPR suggests that:

Although we should always expect a medical record to be populated with data about a specific patient, in the electronic

implementation of records we also expect to find data regarding populations of patients, integrated access to the biomedical literature, and interactive environments for offering clinical guidelines or frank consultative advice. [5]

LIBRARIANS AND INFORMATICIANS: NEW ROLES AS "BOUNDARY SPANNERS"

Librarians' traditional roles of selecting, organizing, developing, and disseminating information represent skills that are transferable and valuable in any information-intensive environment, particularly one as rich and complex as health care. The imperative of information in the health care environment is that the proper knowledge must be delivered to the right person, at the right time, in the right place [19]. In *To Err Is Human*, various health-related professional societies and accrediting agencies have recommended that new information delivery systems be based on scientific knowledge and that the information supporting that knowledge be evidence-based and easily available, shareable, and accessible [20]. Building on a systems-based approach, *Crossing the Quality Chasm* has exhorted changes in the medical care system, explicitly stating that information technology be used to support clinical and administrative processes [21].

In medicine's knowledge-intensive environment, librarians have emerged as agents with unique skills to take advantage of the diverse opportunities that exist to help organizations cope more effectively with the external trends and forces currently affecting the role and value of information [22]. Bibliographic information is *not* the only province or concern of the librarian. Libraries are more than storehouses of books, and librarians, as providers and mediators of information resources, have an active role in disseminating information resources as widely as possible. The introduction of DPRs, coupled with the ability to access knowledge-based resources, provides the context to promote and develop synergy among those who support the health informatics process, including all those who provide information as well as the recipients of information, such as health care practitioners and service users [23].

As health care has become more multidisciplinary and knowledge dependent, librarians and informaticians are increasingly seen as "boundary spanners" who can bridge the technical and the human information needs inherent in providing health care. Librarians and informaticians have asserted their roles as content developers, by possessing and applying their skills and insights concerning the value of metadata, categorization, and descriptive vocabularies, skills, and insights that are in fact hallmarks of *both* information management domains. Working together, librarians and informaticians can take increasingly sophisticated databases focused on health care applications and conjoin research literature and patient or clinical data for information visualization and discovery, as well as create new alerting systems [16]. Librarians' and informaticians' backgrounds in infor-

mation systems and Web design, as well as their understanding of the human-computer interface, provide a solid position for contributing to health institutions' information infrastructure needs [20].

Librarians and informaticians understand the advantage of information technology in providing wider and easier access to information. Libraries and librarians have been early adopters of new technology, and informaticians have been key players in moving information technology in health care beyond administrative applications. Both groups fully understand that computers and networking provide more efficient and effective ways to store, organize, and retrieve the large amounts of information essential to today's health environment [2]. NLM has long recognized the natural synergy between libraries and informatics and is a primary funder for informatics training and Integrated Advanced Information Management Systems (IAIMS) [2].

CONCLUSION

As introducers and adopters of new information management technologies, librarians and informaticians are poised to serve as key players in health care planning teams for information-related issues. Becoming key players requires staking out new professional ground, not for possession but for participation [22]. This expertise can in turn be used to shape institutional information policy. To succeed and advance in this arena, however, librarians and informaticians must remain competent and further enhance their expertise with systems and subject matter beyond the traditional scope of their respective domains [24].

Information systems can serve many uses. Systems delivering the DPR can deliver patient information and the knowledge needed to aid the health care provider in decision making. Providers have information needs that are both complex and diverse [25], and information technology has the potential to free health care professionals, so they remain mobile in the clinical or research enterprise and have access to the knowledge-based work tools they need in their workflow. Informaticians and librarians are boundary spanners who can look at information delivery in a holistic fashion, remembering the human factors that must unite technology and care delivery.

Boundaries are disappearing among the published literature, research data, research databases, and clinical patient data. As research literature increasingly exists alongside repositories of source evidence, large bodies of data can be used to support individual, clinical, or scientific decisions. These datasets may be incorporated and manipulated into knowledge sources through creating application-focused databases. Opportunities exist for both informaticians and librarians to create, maintain, and develop these integrated information resources [23].

REFERENCES

1. MATHESON N. Things to come: postmodern digital knowledge management and medical informatics. *J Am Med Inform Assoc* 1995 Mar-Apr;2(2):73-8.
2. FRISSE M, BRAUDE R, FLORANCE V, FULLER S. Informatics and medical libraries: changing needs and changing roles. *Acad Med* 1995 Jan;70(1):30-5.
3. COLLEN M. Preliminary announcement for the Third World Conference on Medical Informatics. *Medinfo* 1977; 80.
4. VAN BEMMEL JH. The structure of medical informatics. *Med Inform (Lond)* 1984 Jul-Dec;3-4:175-80.
5. BLOIS M, SHORTLIFFE E. The computer meets medicine: emergence of a discipline. In: Shortliffe E, Perreault L, eds. *Medical informatics: computer applications in health care*. v.20. Reading, MA: Addison-Wesley, 1990.
6. ESKIND BIOMEDICAL LIBRARY, VANDERBILT UNIVERSITY DEPARTMENT OF BIOMEDICAL INFORMATICS. About us. [Web document]. Nashville, TN: The Department, 2002. [8 Dec 2002; cited 14 Dec 2004]. <<http://www.mc.vanderbilt.edu/dbmi/people/>>.
7. STEAD WW. Medical informatics—on the path toward universal truths. *J Am Med Inform Assoc* 1998 Nov-Dec;5(6):583-4.
8. DE LUSIGNAN S. What is primary care informatics. *J Am Med Inform Assoc* 2003 Jul-Aug;10(4):304-9.
9. AMERICAN SOCIETY FOR INFORMATION SCIENCE AND TECHNOLOGY. The society and its history: ASIS&T and its members. [Web document]. Silver Springs, MD: The Society, 2004. [cited 14 Dec 2004]. <<http://www.asis.org/AboutASIS/the-society.html>>.
10. BUCKLAND M. *Library services in theory and context*. Elmsford, NY: Pergamom Press, 1983.
11. FLORANCE V. Better Health 2010: a report by the AAMC's better.health 2010 Advisory Board. Association of American Medical Colleges. (Available at: <www.aamc.org/betterhealth/>). [cited 30 Sep 2003].)
12. DALRYMPLE P. Improving health care through information: research challenges for health sciences librarians. *Libr Trends* 2003 Spring;51(4):525-40.
13. BRADLEY J. The changing face of health information and health information work: a conceptual framework. *Bull Med Libr Assoc* 1996 Jan;84(1):1-10.
14. ABBOTT A. *The system of professions: an essay on the division of expert labor*. Chicago, IL: University of Chicago Press; 1988.
15. STEAD WW, MILLER RA, MUSEN MA, HERSH WR. Integration and beyond: linking information from disparate sources and into workflow. *J Am Med Inform Assoc* 2000 Mar-Apr;7(2):135-45.
16. LYNCH C. Medical libraries, bioinformatics, and networked information: a coming convergence? *Bull Med Libr Assoc* 1999 Oct;87(4):408-14.
17. STEAD WW, HAYNES RB, FULLER S, FRIEDMAN CP, TRAVIS LE, BECK JR, FENICHEL CH, CHANDRASEKARAN B, BUCHANAN BG, ABOLA EE. Designing medical informatics research and library—resource projects to increase what is learned. *J Am Med Inform Assoc* 1994 Jan-Feb;1(1):28-33.
18. HUMPHREYS BL. Electronic health record meets digital library: a new environment for achieving an old goal. *J Am Med Inform Assoc* 2000 Sep-Oct;7(5):444-52.
19. FLORANCE V, GIUSE NB, KETCHELL DS. Information in context: integrating information specialists into practice settings. *J Med Libr Assoc* 2002 Jan;90(1):49-58.
20. HOMAN JM, MCGOWAN JJ. The Medical Library Association: promoting new roles for health information professionals. *J Med Libr Assoc* 2002 Jan;90(1):80-5.

21. COMMITTEE ON QUALITY HEALTH CARE IN AMERICA, INSTITUTE OF MEDICINE. Crossing the quality chasm: a new health system for the 21st century. Washington, DC: National Academies Press, 2001.
22. RAMBO N. An operational view of the role of health librarians in informatics. *Health Libr Rev* 1994;II:161–6.
23. PLAICE C. Information for health: the opportunity to consolidate partnership working between librarians and other health informatics professions. *Health Libr Rev* 2000 Jun; 17(part 2):103–9.
24. GIUSE NB, HUBER JT, GIUSE DA, KAFANTARIS SR, STEAD WW. Integrating health sciences librarians into biomedicine. *Bull Med Libr Assoc* 1996 Oct;84(4):534–40.
25. GIUSE NB, HUBER JT, KAFANTARIS SR, GIUSE DA, MILLER MD, GILES DE, MILLER RA, STEAD WW. Preparing librarians to meet the challenges of today's health care environment. *J Am Med Inform Assoc* 1997 Jan–Feb;4(1):57–67.

Received April 2004; accepted November 2004